

## AFGL INFRARED SURVEY EXPERIMENTS CLEANING PROCEDURE

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### ABSTRACT

Space borne cryogenically cooled infrared telescope systems are optically sensitive to particulate contamination along the line-of-sight. Methods of cleaning and handling flight instrumentation have been developed at AFGL and used on the Infrared Celestial Survey program. These procedures are described in detail and flight results are presented.

#### 1.0 INTRODUCTION

The Air Force Geophysics Laboratory is conducting a program of experiments to survey the sky in the infrared spectral region. The effect of particulate contamination upon infrared experiments in space has long been recognized (1,2,3,4,5,6) so payload design and handling techniques have been developed to minimize the possibility of dust and dirt in the experimental environment.

1. Blanchard, M.B., Farlow, N.H., Ferry, G.V. and Shade, H.D. 1967. Sixth Annual Technical Meeting, American Association for Contamination Control.
2. Blanchard, M.B., Ferry, G.V. and Farlow, N.H. 1968. J. Geophys. Research Space Physics, 73, 6343.
3. Blanchard, M.B. and Farlow, N.H. 1966, Contamination Control Vol. 5, 22.
4. Walker, R.G. and Price, S.D. 1975, AFCRL-TR-75-0373, ERP No. 522.
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6. Price, S.D. 1977, AFGL-TR-77-160, ERP No. 606.

## 2.0 THE EXPERIMENT

The experimental payload, Figure 1, consists of the nose cone, stellar tracker, stellar aspect sensor, a super critical helium-cooled infrared radiometer, instrument support section, attitude control system, and the recovery package. Aerobee sounding rockets are used as the propulsion vehicles for these experiments. After rocket burnout the payload and sustainer are separated by means of a Marmon clamp release and pre-loaded separation springs; sensor doors, nose tips and stellar aspect sensor doors are then ejected and the payload despun. Figure 2. The attitude-control-system captures the payload and points the star tracker, coaligned to the rocket roll-axis, to a pre-selected star near local zenith. The infrared sensor cap is lowered and the radiometer deployed to a specific zenith angle. Figure 3.

The payload is rotated about the roll-axis allowing the radiometer to scan a portion of the sky measuring the infrared sources. After completion of a 360 degree roll the radiometer is stepped through an angle slightly less than its field-of-view to permit mapping a contiguous sector of sky. At the conclusion of data taking the radiometer is returned to the stowed position and the recovery system actuated. Approximately 9000 to 10000 square degrees are scanned during each flight.

By precise selection of the launch window and site, mapping the entire celestial sphere can be accomplished.

## 3.0 PAYLOAD DESIGN

The nose tip, Figure 4, is built in two sections with an "O" ring seal to prevent particulate contamination after cleaning and mounting. The stellar aspect sensor port shown in Figure 5 contains two "O" ring seals. The outer seal is a dust safeguard between the rocket skin and the stellar aspect sensor port and the second is a seal for the ejectable door. Figure 2 is a view of the helium-cooled infrared radiometer in the

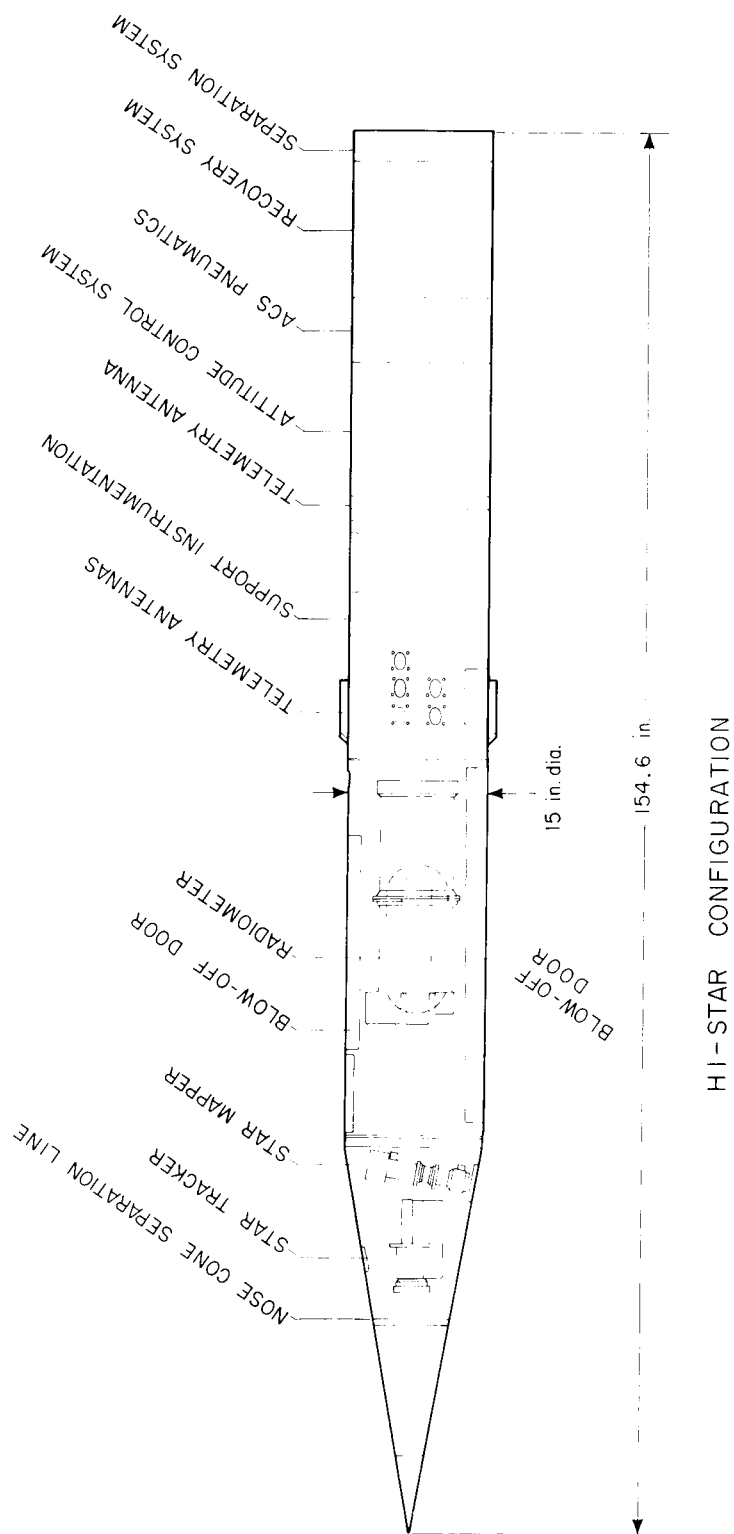


FIGURE 1 - HI STAR CONFIGURATION

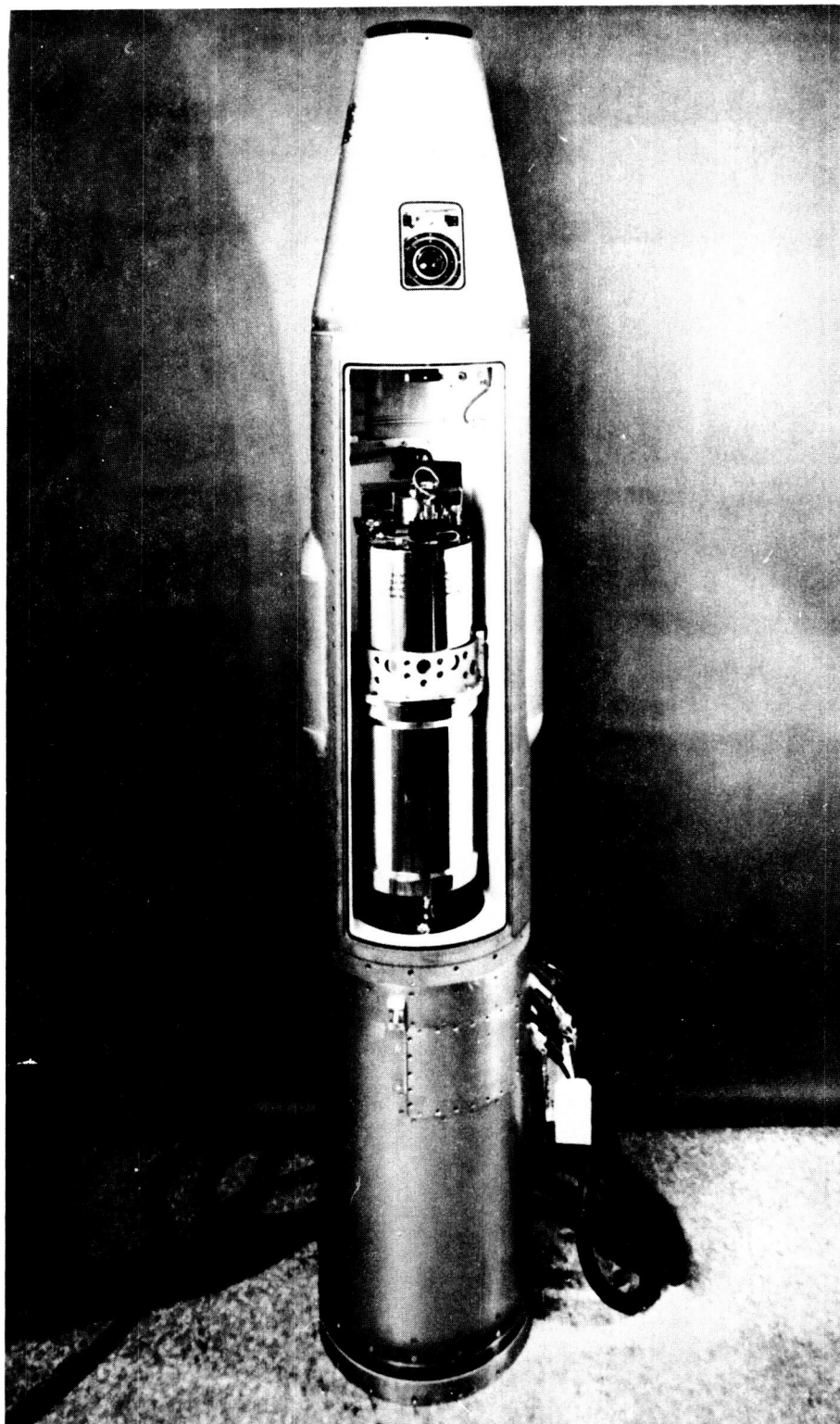


FIGURE 2 - PAYLOAD AFTER SEPARATION, NOSE TIPS AND  
DOOR EJECTION

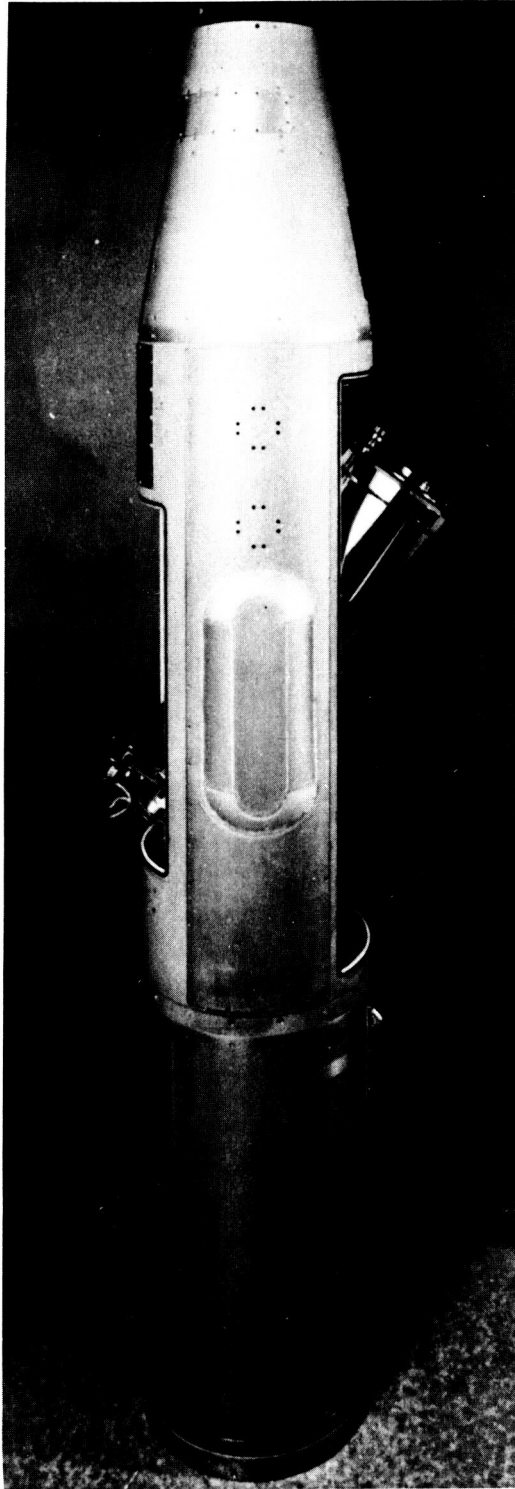


FIGURE 3 - RADIOMETER DEPLOYED

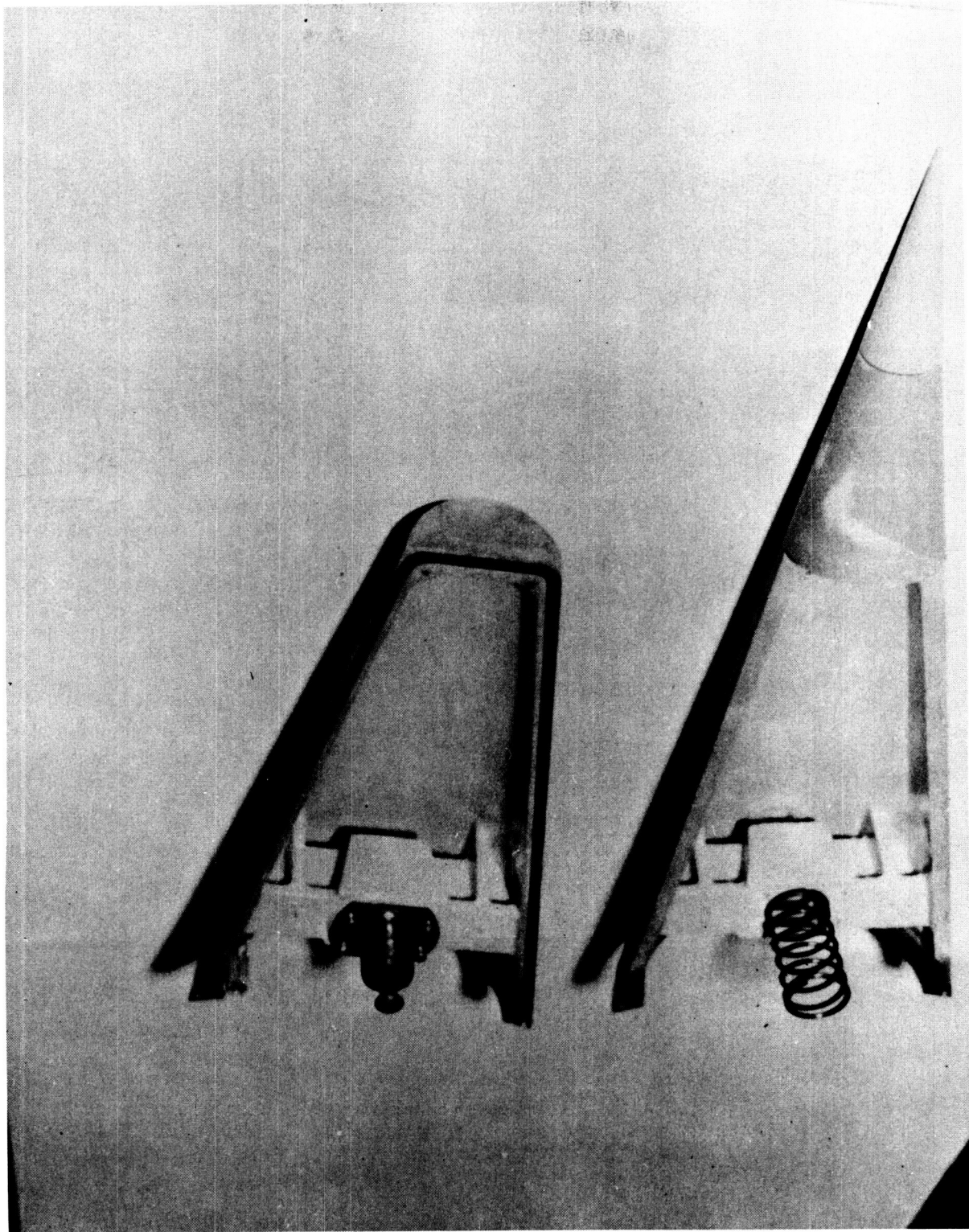


FIGURE 4 - NOSE TIP PRIOR TO INSTALLATION

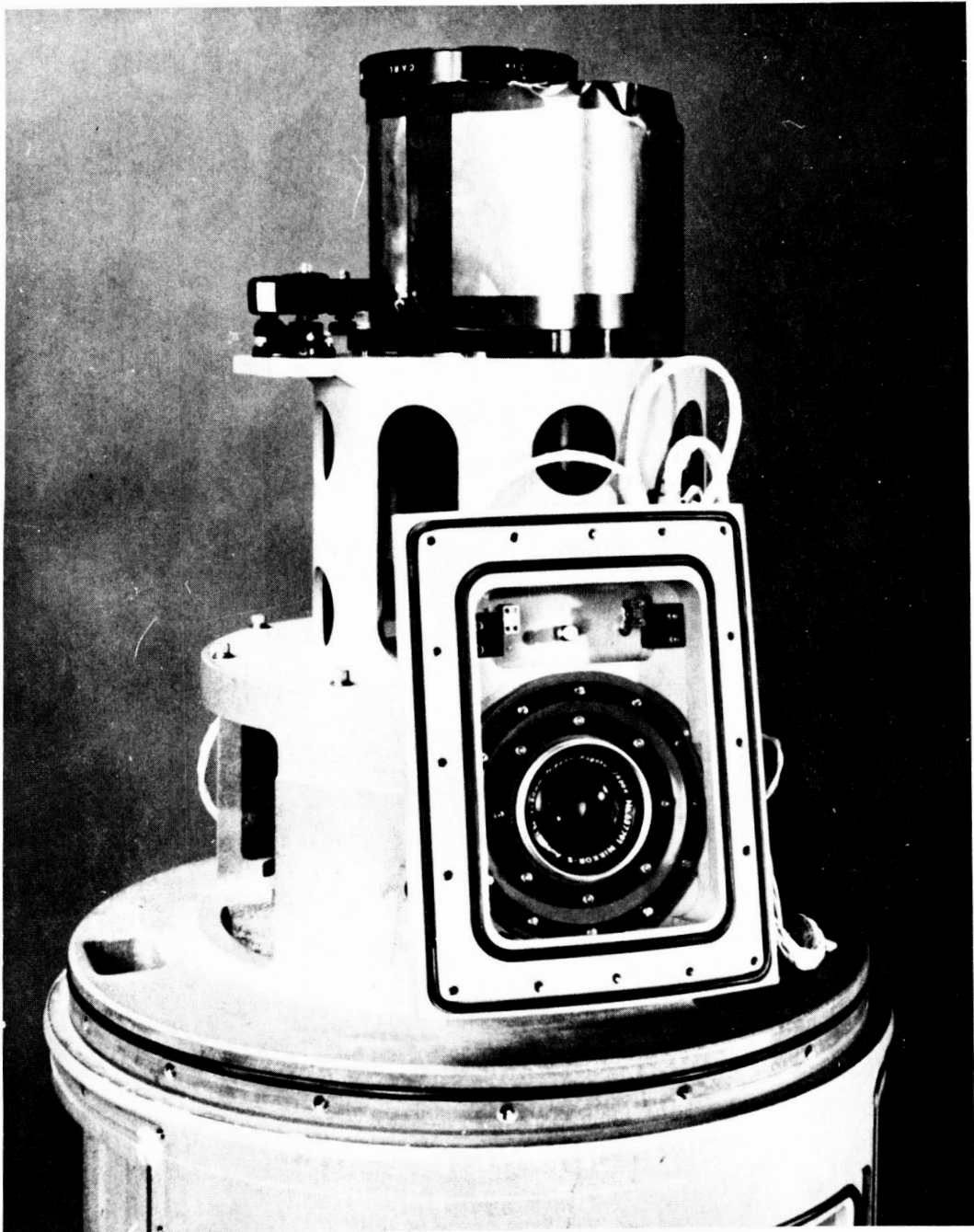


FIGURE 5 - STELLAR ASPECT SYSTEM PORT

stowed position. The surface of this cavity is treated with a hard glossy epoxy paint that allows a cling free, easily cleaned area. The cavity is separated from the stellar aspect sensor and stellar tracker section by a solid bulkhead and from the support section immediately below by a rubber gasket attached to the sensor cap. Servicing the infrared radiometer in the tower prior to launch is performed through an access door observed at the rear of the cavity and directly above the radiometer.

Purging of atmospheric pressure during rocket ascent is accomplished by two methods. First, the clean air in the sensor chamber is vented through one way 1.0 psi check valves mounted on the skin. Second, the contaminated air in the support section and tracker-aspect sensor section is vented to the side panel section, Figure 6, through clearances in the casting, and then out the side panels, Figure 7, through Millipore filters, effectively containing contamination inside a "dirty" area.

#### 4.0 CLEANING

##### 4.1 Clean Bench and Clean Room

Both the clean work station, used for the assembly and disassembly of the infrared radiometer, and the clean room provide a laminar flow of 100 feet per minute of filtered air. Prefiltering achieves 60% efficiency and final filters of the absolute type increases effectiveness to 99.97 percent on particles exceeding 0.3 microns diameter.

Preparation of the clean room requires complete vacuuming, soap and water scrubbing, rinsing, and a two day purge. Clean room efficiency is continuously monitored by instrumentation designed to detect particles greater than 0.5 micron diameter. A visual display counter gives digital particle counts and an audio alarm alerts the user to an unexpected violation of cleanliness standards. All work in the clean room ceases and remedial action initiated if a breakdown in standards occur. Normal operation is resumed when corrections have been completed and the required

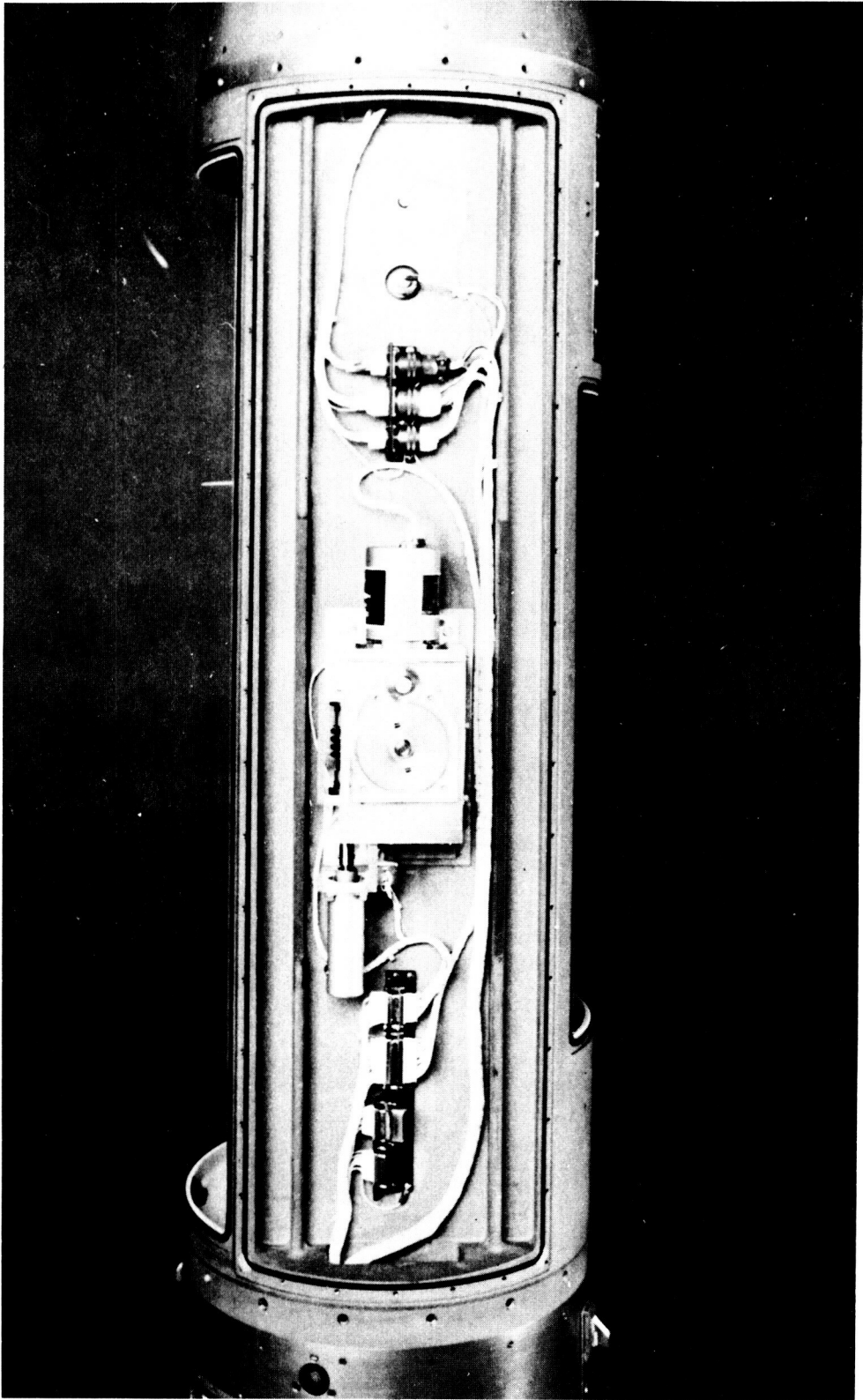


FIGURE 6 - SIDE PANEL SECTION SHOWING COMBINATION VENT AND CABLE HOLES AT THE TOP AND BOTTOM OF THE SECTION

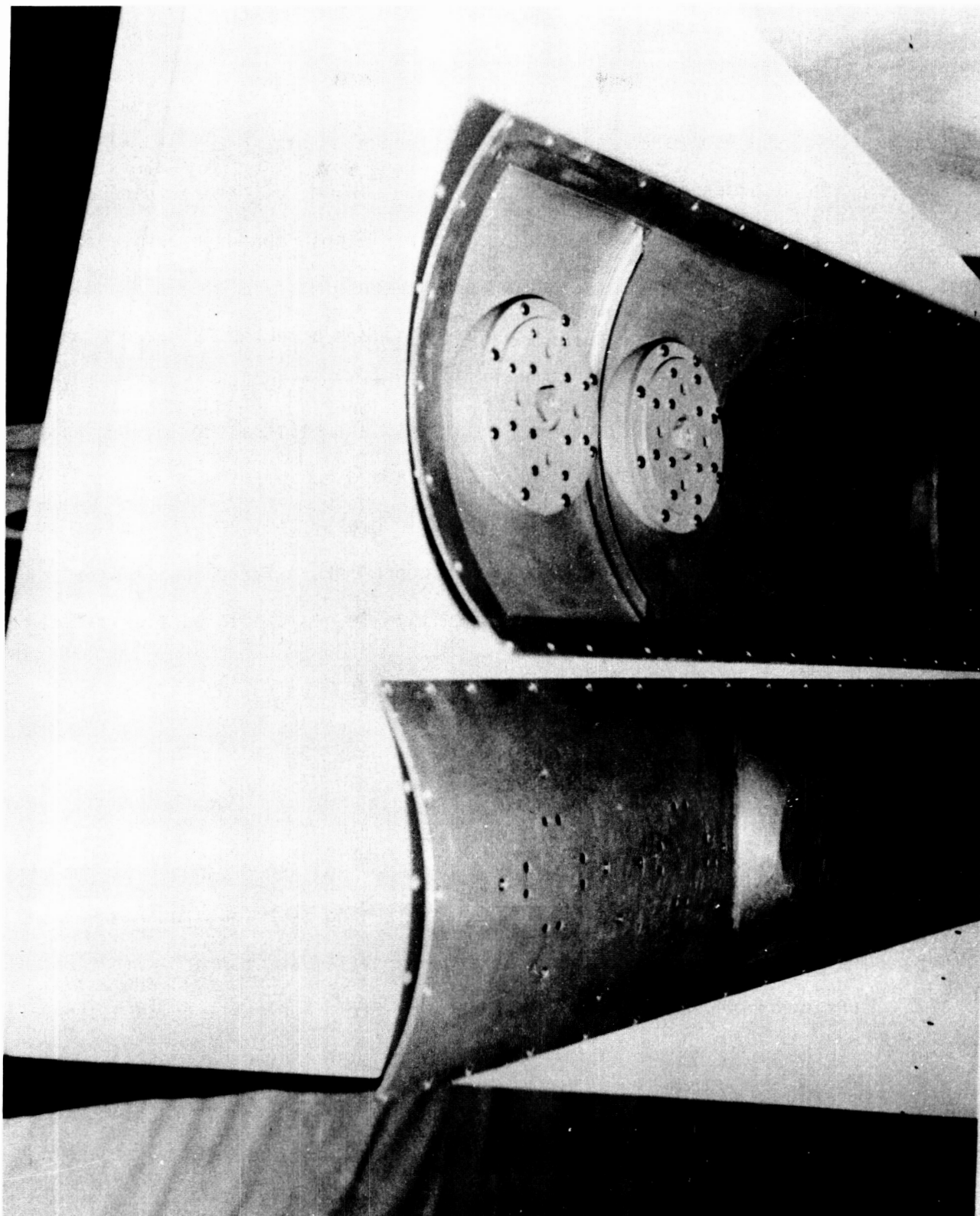


FIGURE 7 - SIDE PANELS WITH MILLIPORE FILTER HOLDERS  
ON THE INSIDE AND VENT HOLES ON THE OUTSIDE

cleanliness attained.

#### 4.2 Equipment

Clean room clothing consists of frocks, boots, hats, and gloves. Freon TF grade is used as a purging agent in an ultrasonic cleaner for all small parts including the separable nose cone, screws, washers, and all tools used in the clean room. Aerosol cans of freon and microscopically clean air, with 0.5 micron filters attached, dislodge particles in inaccessible area. An ultraviolet light is used to detect lint, dust, and other fluorescent materials and establishes the level of payload cleanliness as well as that of all tools and equipment used in the clean room. A vacuum cleaner, a stiff bristle brush, and the ultraviolet light is used to examine and eliminate all contaminants including fluorescent materials from exposed surfaces resulting in negligible particulate contamination.

#### 4.3 Procedures

##### 4.3.1 Mirror Cleaning

The infrared radiometer telescope primary and secondary mirrors used during HI STAR SOUTH flights were super-polished canogen-coated-beryllium first surface mirrors. Special cleaning techniques were developed to prevent degradation of scattering properties and contact with mirror surfaces was restricted to liquids. The first application was a spray of acetone to remove surface contaminants such as vacuum grease and finger prints. A spray of 99.9 percent pure ethyl alcohol removed residual acetone and dissolved any grease or oil. A bath of distilled water and non-ionic soap or very mild dishwashing detergent removed any alcohol residue. Finally, flooding the mirror with distilled water removed any residual soap solution. This process is repeated until visual inspection indicates all deposition is removed. If repeated applications of the above procedure

fail to remove contamination, strips of Kay Dry tissues thoroughly saturated with each of the liquids are drawn, without surface pressure, across the mirrors. This technique has effectively removed contamination in all operations.

#### 4.3.2 Payload Cleaning

Areas requiring absolute cleanliness include the nose cone, stellar tracker and stellar aspect system detents, radiometer section, and the entire outer skin of the payload. The payload, Figure 1, is positioned horizontally on a cradle designed with rollers to permit effortless rotation and maximum access to all sections to be cleaned. The nose cone end of the payload is canted slightly and positioned close to the clean room filter bank placing cleaned areas and those being cleaned between the filter bank and personnel during cleaning functions.

Nylon lint-free cloths are used to apply liberal quantities of clean freon over the skin of the payload around the stellar tracker mounting area. This detent is then vacuumed and checked with the aid of an ultra violet light. The exposed tracker lens is cleaned with standard lens paper and Kodak lens cleaner. At this point the pre-cleaned separable nose cone is assembled and secured to the payload. Again the skin is flushed to below the stellar aspect system detent and vacuumed. The aspect system door, purged in the ultrasonic cleaner, is then secured to the payload and an ultraclean polyethylene antistatic bag cut to the full length of the payload is pulled over the nose and down along the payload to a point just below the aspect system door thereby isolating the upper cleaned portion from contamination.

The most intricate and complicated portion to undergo cleaning is the infrared radiometer sensor and cavity area. Once again the payload exterior from below the bagged area to below the cavity is washed with liberal amounts of freon and vacuumed. The radiometer exterior, casting

cavity, cables, and connectors are cleaned in preparation for the opening of the infrared radiometer. The radiometer cap is then lowered, the sensor deployed some 90 degrees, and the interior vacuumed. The infrared radiometers are assembled on a clean bench and contaminants are rarely found inside at this time. On completion of the cleaning, the radiometer is stowed and the cap raised in place. Equipment used to service the radiometer in the launch tower consists of a helium fill line, a vacuum pump port, and a vent heater cable, all thoroughly cleaned and attached through a split access door. The sensor cavity is re-inspected for contaminants, cleaned if required, and isolated with the attachments of the pre-cleaned ejectable doors. The exposed outer payload skin is purged, re-cleaned, and the polyethylene bag moved along to cover the payload to below the sensor door. The remainder of the payload from a point below the radiometer section to the bottom of the payload separation joint is systematically cleaned with freon and vacuumed, isolating each section after cleaning by moving the clean bag along the skin.

To gain access for servicing of parts of the payload encased in the clean bag, polyethylene sleeves are fabricated and attached to the bag at strategic locations. One such place is at the temporary service door for the radiometer. In addition to the vacuum pump and liquid helium lines in this area, a small clean bag containing the pre-cleaned permanent door and other equipment used in preparation for final "buttoning up" is inserted in the sleeve. Other sleeves are fabricated to provide access to the payload timers, flight battery doors, umbilical connector section, and attitude control system battery door. A second clean bag is subsequently stretched over the entire payload to protect the package during transportation, mating with the rocket sustainer, and emplacement in the launch tower. Connector ends of all umbilical cables are cleaned with freon, ultraviolet light tested, vacuumed, and

then doubly bagged to prevent contamination during mating with the payload on the launch tower.

All bagging material, Figure 9, remained on the payload until seventy five minutes before launch at which time it was washed down, slit, and peeled off.

## 5.0 RESULTS

Seven rockets have been successfully launched, Figure 10, at White Sands Missile Range, and three at Woomera, Australia. The ten launches of the HI STAR and HI STAR SOUTH program surveyed ninety percent of the sky at 11 and 20 microns locating and identifying some 3200 celestial objects, Figure 11.

## 6.0 ACKNOWLEDGEMENTS

The payload was designed by Paul Hartnett and Edwin LeBlanc of Wentworth Institute and C. Neil Stark of the Geophysics Laboratory. The attitude control system and recovery package were provided by Aerojet Liquid Rocket Co. Cleaning was done by David Akerstrom, Michael Mitchell, Dr. Thomas Murdock and Anthony Romanelli of AFGL with the assistance of Wentworth Institute personnel. The experiments described were conducted under the supervision of Dr. Russell G. Walker, Chief project scientist at AFGL.

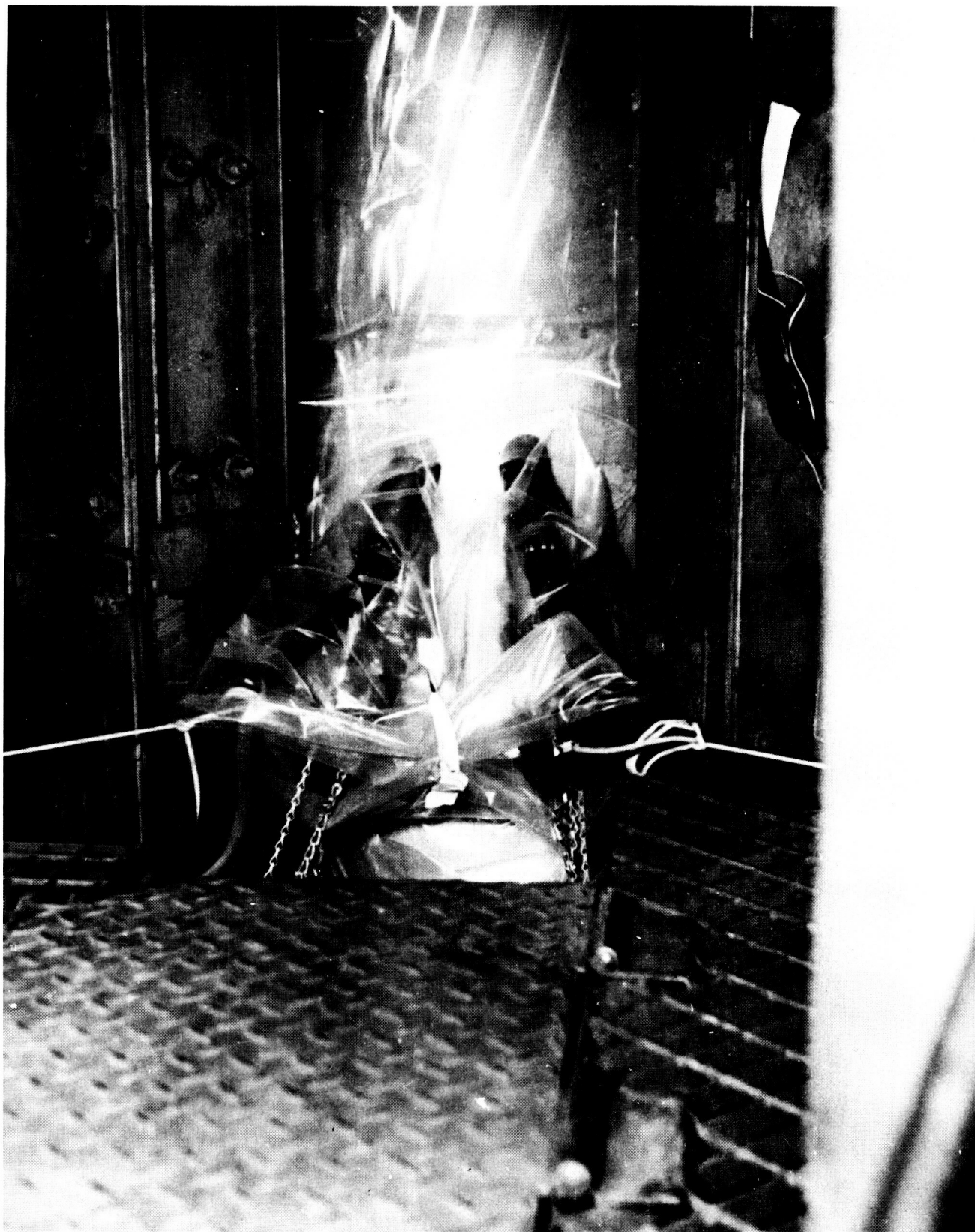


FIGURE 8 - PORTION OF BAGGED PAYLOAD AND UMBILICAL  
CABLE CONNECTIONS IN THE LAUNCH TOWER



FIGURE 9 - NOSE TIP OF PAYLOAD ENSHROUDED IN  
POLYETHYLENE BAGGING MATERIAL ON  
THE LAUNCH TOWER

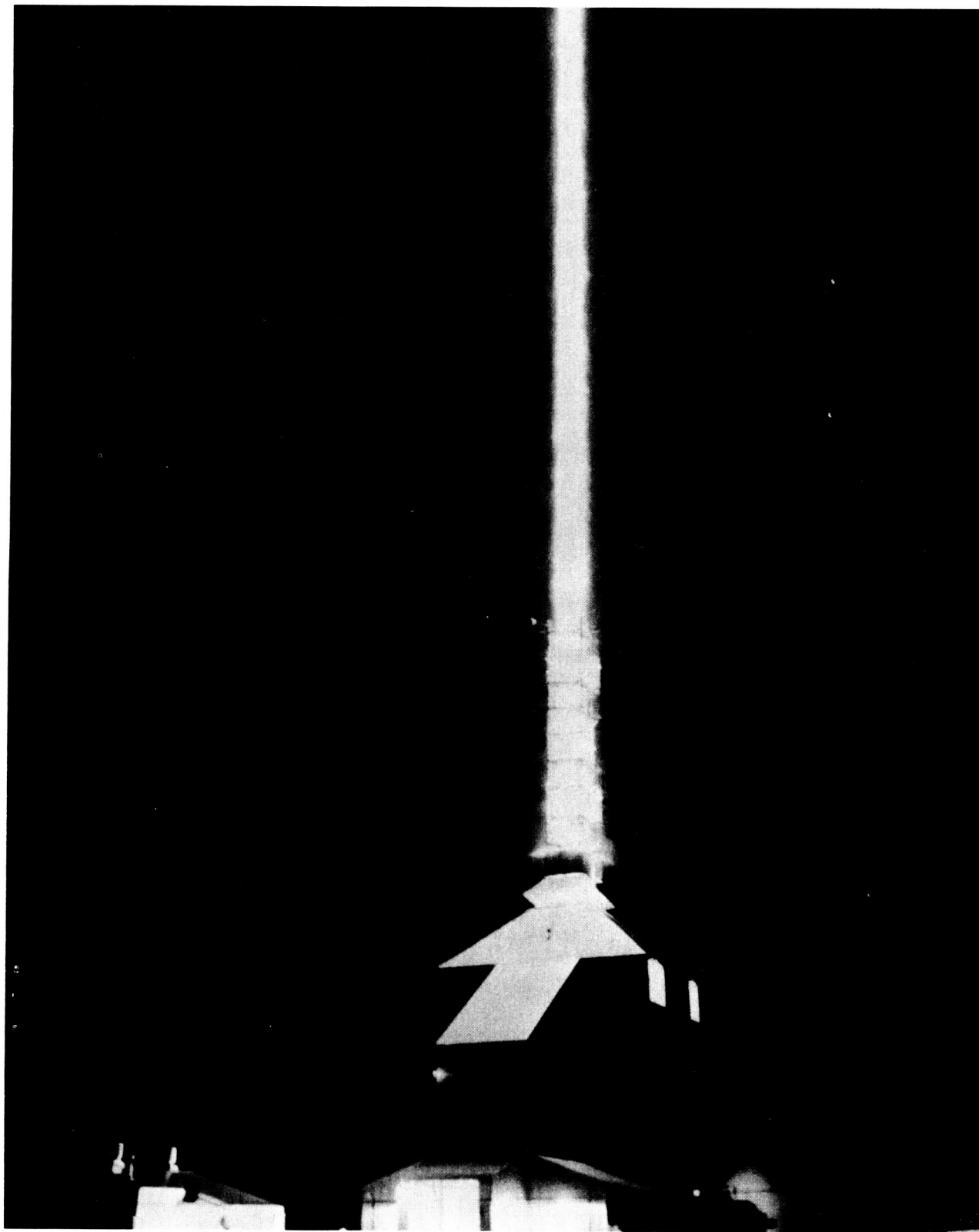


FIGURE 10 - TYPICAL HI STAR AEROBEE LAUNCH

# SOURCES OBSERVED AT 11.0 MICRONS

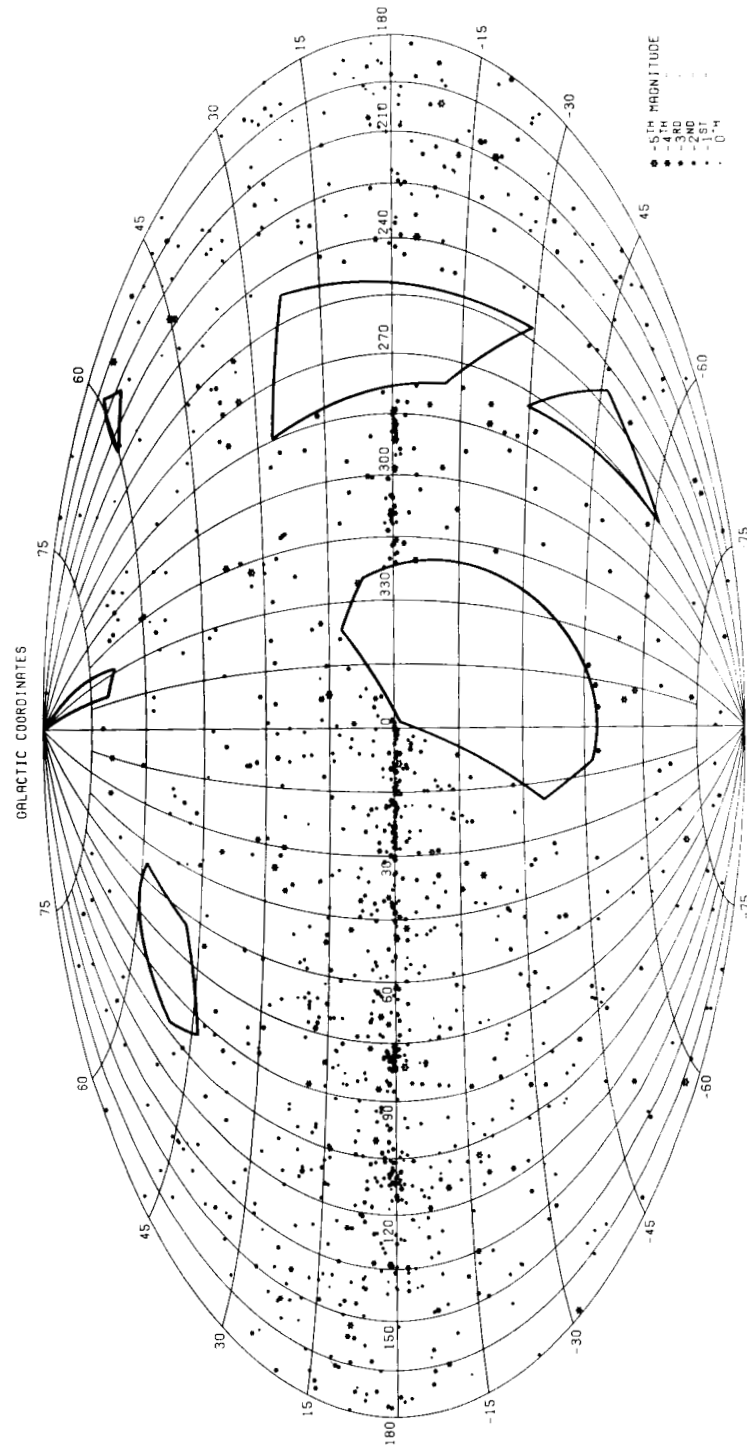


FIGURE 11 - INFRARED SOURCES AT 11 MICRONS AS OBSERVED DURING HI STAR FLIGHTS

## 7.0 REFERENCES

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